SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

AD-A261 388

1a. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS: Public release; distribution unlimited
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S): AFOSR-TR- 3
6a. NAME OF PERFORMING ORGANIZATION: The Regents of the Univ. of California, San Diego	6b. OFFICE SYMBOL (If applicable): --
7a. NAME OF MONITORING ORGANIZATION: Air Force Office of Scientific Research/NL	
6c. ADDRESS (City, State and ZIP Code): University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093	7b. ADDRESS (City, State and ZIP Code): Bldg. 410, Bolling Air Force Base, D.C. 20332-6448
8a. NAME OF FUNDING/SPONSORING ORGANIZATION: AFOSR/NL	8b. OFFICE SYMBOL (If applicable): NL
9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER: AFOSR-91-0191	
8c. ADDRESS (City, State and ZIP Code): Bldg. 410, Bolling Air Force Base, D.C. 20332-6448	10. SOURCE OF FUNDING NOS: PROGRAM ELEMENT NO; PROJECT NO: 2313; TASK NO: A4; WORK UNIT NO
11. TITLE (Include Security Classification): Comparative Analytical Study of Evoked and Event Related Potentials As Correlates of Cognitive Processes	
12. PERSONAL AUTHOR(S): Bullock, Theodore Holmes	
13a. TYPE OF REPORT: Final Technical	13b. TIME COVERED: FROM 2/1/91 TO 10/31/92
14. DATE OF REPORT (Yr, Mo, Day): 92/12/21	15. PAGE COUNT
16. SUPPLEMENTARY NOTATION	

17. COSATI CODES		
FIELD	GROUP	SUB. GR.

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number):
Electroencephalogram
Event Related Potentials
Evoked Potentials

19. ABSTRACT (Continue on reverse if necessary and identify by block number):

This project permitted collaboration between Prof. Erol Basar in Lübeck and Dr. Bullock on new views and analyses of cognitive Event Related Potentials (ERPs), evoked oscillations (Induced Rhythms, IRs) and their relations to the EEG. ERPs have been found for the first time in nonmammalian models (fish, turtles), especially Omitted Stimulus Potentials (OSPs) and oddball ERPs and Mismatch Potentials. To compare the dynamics of these models with human ERPs, a new series of human subjects has been run, extending the range of inter-stimulus intervals; this showed two types of OSP with distinct dynamics - including a short ISI type not heretofore recognized. Basar and Bullock co-edited a book on a new theme: "Induced Rhythms in the Brain" (Birkhäuser Boston, 1992), with 22 chapters by invited experts. The phenomenon of triggered or modulated oscillations has been known for more than 50 years but not been recognized or studied as a category of brain responses; it is now under active investigation in ours and several other laboratories as a possible correlate of certain kinds of cognition.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: UNCLASSIFIED/UNLIMITED X SAME AS RPT ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION: Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL: John Tangney	22b. TELEPHONE NUMBER (Include Area Code): (202) 767-5021
	22c. OFFICE SYMBOL: NL

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE.

SECURITY CLASSIFICATION OF THIS PAGE

FINAL SCIENTIFIC REPORT
ON RESEARCH PROJECT CONDUCTED UNDER AFOSR GRANT
AFOSR-91-0191
"Comparative Analytical Study of Evoked & Event Related Potentials
as Correlates of Cognitive Processes"

by Theodore H. Bullock
Department of Neurosciences, Univ. of Calif., San Diego
La Jolla, CA 92093-0201

This grant continued the collaboration with Prof. Erol Başar (Medical University at Lubeck, Germany), supported previously by AFOSR 89-0456. This report covers both grant periods.

Abstract

This project permitted collaboration between Prof. Erol Başar in Lübeck and Dr. Bullock on new views and analyses of cognitive Event Related Potentials (ERPs), evoked oscillations (Induced Rhythms, IRs) and their relations to the EEG. ERPs have been found for the first time in nonmammalian models (fish, turtles), especially Omitted Stimulus Potentials (OSPs) and oddball ERPs and Mismatch Potentials. To compare the dynamics of these models with human ERPs, a new series of human subjects has been run, extending the range of interstimulus intervals, this showed two types of OSP with distinct dynamics - including a short ISI type not heretofore recognized. Başar and Bullock co-edited a book on a new theme: "Induced Rhythms in the Brain" Birkhäuser Boston, 1992), with 22 chapters by invited experts. The phenomenon of triggered or modulated oscillations has been known for more than 50 years but not been recognized or studied as a category of brain responses; it is now under active investigation in ours and several other laboratories as a possible correlate of certain kinds of cognition.

Introduction and Rationale

Little is known about the basic mechanisms of Evoked Potentials (EPs) and Event Related Potentials (ERPs) - known to be useful objective signs of signal processing and cognitive events in the brain, especially their distribution in the brain, relation to ongoing EEG, dependence on cognition, and uniquely human attributes (Başar 1988; Başar and Bullock 1989 and extensive literature referenced in the original proposal, dated April 7, 1989). In view of the unexpected character of the evolution of ongoing compound field potentials (micro-EEG) of the brain, especially the cortex (Bullock and Başar 1988; Bullock 1988a), and of the comparative neurology of expectation (Bullock 1988b), it appears likely that new insights could be gained by examining whatever signs can be found during administration to lower animal models of the applicable stimulus regimes from among those that have been used on human subjects. Initial results from experiments on rays and teleosts have been reported (Bullock et al. 1990).

Plan of the Collaboration

The present project was planned to take advantage of the mutual interest and complementary facilities of Drs. Bullock and Başar. They can collaborate to some extent by mail, telephone and fax - and have done so extensively in the past. However, this does not realize the potential of the collaboration because each laboratory is the best place to do certain experiments and analyses.

Research Conducted

The plan outlined in the proposal had to be curtailed in time. Bullock had to cancel his trip scheduled for September-October, 1989 at the last minute because of his wife's health and the next opportunity to spend time in Lübeck came in May, 1990 for 10 days. The second trip was in September 1992 for 18 days. Then Dr. C. Başar-Eroglu came to La Jolla in October, 1992 for 3 weeks

After extensive collaboration by mail and wire, an intensive working period was spent in each laboratory. The experiments had been carefully planned, many preparations had been made, everything was ready and worked smoothly, a large part of the staff of each laboratory was involved. This included in Lübeck, in addition to the principal scientists, Dr. Canan Başar-Eroglu, Dr. Tamer Demiralp, Dr Martin Schürmann, Dr. Elke Rahn, the engineer Ferdinand Greischutz, and the technician and graduate student, Mrs. A. Schütt. In La Jolla, the lab personnel involved, besides the principal scientists, were Dr J.Z. Achimowicz, Dr. J.C. Prechtl and Mr. M.C. McClune, engineer.

Among the significant accomplishments were protracted discussion of old data, examination and evaluation of new data, recently gathered by each of the scientists named above, and discussion of important priorities for future research. A new book on a currently hot topic, "Induced Rhythms in the Brain", was co-edited by E. Başar and T.H. Bullock, after recruiting some 20 authors of contributed chapters.

Experiments were carried out during the working visits all day every day. In May 1990 these were about equally divided between those upon trained human subjects (the above named postdoctoral associates) and those upon cats previously surgically implanted with an array of electrodes in the strategic parts of the brain, by Dr. Canan Başar-Eroglu. In September 1992, in Lübeck, all experiments were on human subjects; in October 1992, in La Jolla, all experiments were on Red Eared Turtles. All these joint experiments were supplementary to ongoing experiments in each lab on additional subjects. As a result many tens of megabytes of data are now stored in the computer. The continuous ink records have been scrutinized and those epochs with eye blinks and similar bad places selected out. Many dozens of graphs have been computed, and plotted, in color, both as average potential at each electrode, before and after the target time and as transfer functions of the first derivatives in the chosen band for the period after the target. Tapes of data and printouts of plots and graphs have been exchanged and new analyses and plots have been specified to be done on the stored data. Several papers have been published already. The still incomplete analyses will result in additional papers besides those in the bibliography One will be on the Event Related Potentials to Omitted Stimuli at different interstimulus intervals (ISIs, 1/flash rates) and degrees of regularity in the human (active and passive paradigms).

In the experience of Bullock, the facilities, experience and team available in Lübeck make it uniquely efficient as a place to get such results, both on the human subjects and, until recent complications, on cats, which from practical considerations he cannot now study in his own laboratory in La Jolla.

Principal Findings

1. Nonmammalian models, such as a turtle as well as rays (elasmobranchs) and teleost fish, have good ERPs by the operational definition that a time locked response to a stimulus paradigm causing a cognitive event and ERP in humans is an ERP. The ERPs studied in this project come from the stimulus paradigms of omitted stimuli, oddball stimuli, and mismatch stimuli.

2. These ERPs in nonmammals occur not only in the forebrain areas homologous to mammalian cerebral cortex but also in the midbrain tectum and earlier in the sensory pathway. This includes the retina for visual stimuli (the omitted stimulus or the oddball or mismatched stimulus in a conditioning train) and the first sensory relay nucleus in the medulla for the electrosensory modality. Each successive brain level modulates the ERP it receives from lower levels.

3. The omitted stimulus potential (OSP) in nonattentive nonmammalian subjects tends to have a constant peak latency after the due-time of the first missing stimulus, of ca. 100 ms, regardless of the ISI, but only appears to ISIs up to ca. 0.5 s.

4. The visual OSP in the attentive human has two ranges. In the range of ISIs up to 0.3 s it acts like the foregoing, nonmammalian OSPs. In the range of longer ISIs, essentially one to three seconds, the OSP again has a nearly fixed latency after the due-time but it is usually 350-550 ms and is more sensitive to jitter of ISI.

References

Başar E (1988) Dynamics of Sensory and Cognitive Processing by the Brain. Springer-Verlag, Berlin.

Başar E, Bullock TH (1989) Brain Dynamics: Progress and Perspectives. Springer-Verlag, Berlin.

Başar E, Bullock TH (1992) Induced Rhythms in the Brain. Birkhäuser, Boston.

Başar E, Başar-Eroglu C, Parnefjord R, Rahn E, Schurmann M (1992) Evoked potentials: ensembles of brain induced rhythmicities in the alpha, theta and gamma ranges. In Induced Rhythms in the Brain. E Başar, TH Bullock eds, Birkhäuser, Boston, pp 155-181

Bullock TH (1988a) Compound potentials of the brain, ongoing and evoked: perspectives from comparative neurology. In Dynamics of Sensory and Cognitive Processing by the Brain. E Başar ed, Springer-Verlag, Berlin, pp 3-18

Bullock TH (1988b) The comparative neurology of expectation: stimulus acquisition and neurobiology of anticipated and unanticipated input. In Sensory Biology of Aquatic Animals. J Atema, RR Fay, AN Popper, WN Tavolga eds, Springer-Verlag, New York, pp 269-284

Bullock TH (1991) New descriptors for the activity of brain cell assemblies: requirements and opportunities. In Nonlinear Dynamics and Neuronal Networks. HG Schuster ed, VCH Verlagsgesellschaft, Weinheim, Germany, pp 257-266

Bullock TH (1992) Introduction to induced rhythms: a widespread, heterogeneous class of oscillations. In Induced Rhythms in the Brain. E Başar, TH Bullock eds, Birkhäuser, Boston, pp 1-26

Bullock TH, Başar E (1988) Comparison of ongoing compound field potentials in the brains of invertebrates and vertebrates. Brain Res Rev 13:57-75

Bullock TH, Achimowicz JZ, McClune MC (1992a) Forays into microstructure of EEG in space and time. Proc Ann Res Symp INC, University of California, San Diego, pp 11-47

Bullock TH, Karamürsel S, Hofmann MH (1992b) The neurobiology of expectation: interval-specific event related potentials to omitted stimuli in the electrosensory pathway in elasmobranchs. Proc. Third Int. Cong. Neuroethol, Montreal #227

Prechtl JC, Bullock TH (1992) Barbiturate sensitive components of visual ERPs in a reptile. Neuroreport 3:801-804

Schutt A, Başar E (1992) The effects of acetylcholine, dopamine and noradrenaline on the visceral ganglion of helix pomatia - II. Stimulus evoked field potentials. Comp Biochem Physiol 102C:169-176

Schutt A, Başar E, Bullock TH (1992) The effects of acetylcholine, dopamine and noradrenaline on the visceral ganglion of helix pomatia-I. Ongoing compound field potentials of low frequencies. Comp Biochem Physiol 102C:159-168

Theodore H. Bullock
December 21, 1992